Practical-2

AIM: Understand and identify header fields of layers of TCP/IP protocol stack.

Tools Required: WordPad or Notepad.
Submission: After writing the answer into this word document, Student needs to change name to his ID followed by a practical number. Ex 20ce005_Pr1.docx. Upload on assignment segment.
Rubrics: Nicely drafted document with clarity in answers leads to full marks. Otherwise, submission carries a proportional mark.

Watch and refer following videos for a better understanding of the header fields of layers of TCP/IP:

Material 1. **Ethernet frame ():** https://www.youtube.com/watch?v=SoTRqDLND6Y
Material 2. **IPv4 header format ()**: https://www.youtube.com/watch?v=3Y70y6dM7Cs
Material 3. **IPv4 Vs IPv6()**: https://www.youtube.com/watch?v=NkE9_iRPi1I
Material 4. **TCP and UDP ():** https://www.youtube.com/watch?v=r4HbLQuqvrM

Students need to fill the empty table and write answers to questions.

As per the discussion in classroom, any user starts internet access through browser or network applications. Following figure 2.1 explain scenario of receiving data at NIC Card. NIC card receives signals and it converts into sequence of 0's and 1's. After receiving data it sends data for the further processing to TCP/IP protocol stack. In this exercise you need to identify boundaries of fields of headers, describe and understand flow of information in protocol stack.

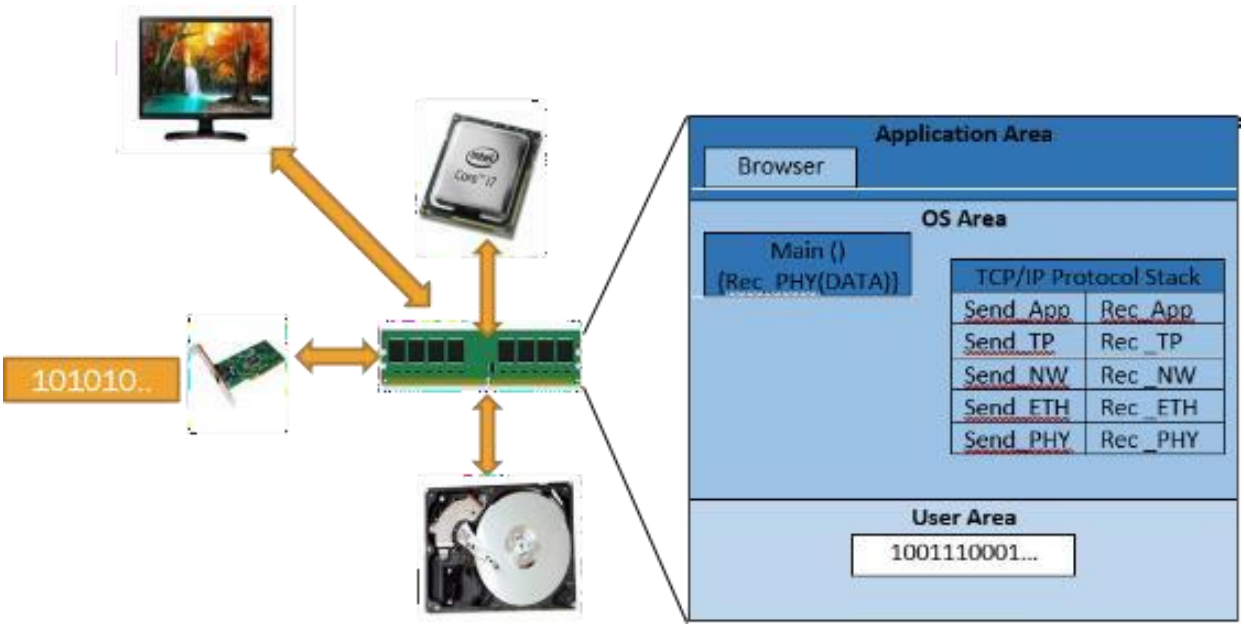

Figure 2.1 Real Scenario

2.1 Input data stream: TCP

This is the data stream which receiver NIC card receives from wire and stores into memory. Length of bits stream is 432 bits.

000000000001101010001100011010111011010101100111010001101100011010001010001101111001111110001000010000000000001000101000000000000000000010100000010101101111010100000000000000010000000000001100000000000000000010101100000100000000110001111011000111011111010101101110100111011000101011100110000000011011101101001001111011110111100100000100000011010001001110101000000010000000100000000101011111110111011100000000000000000

Abstract view of data with respect to the location of headers and data in the actual data stream.

Data Link (Ethernet) Header	Network Header	Transport Header	Data

Initial 112 bits contains Ethernet Header (Refer section 2.2), Next 160 bits contains IP Header (Refer section 2.3), Next 160 bits contains TCP Header (Refer section 2.4).

2.2 Header format of Ethernet

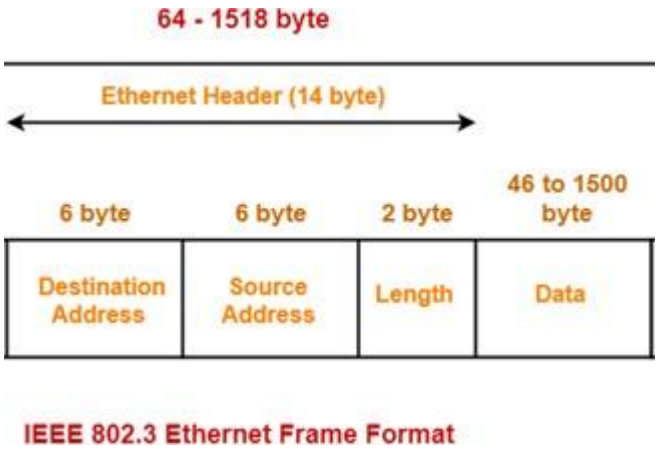

Figure 2.2 Ethernet Header Format

Section 2.1 contains bit stream. copy and paste respected number of bits into following table 2.1 to prepare ethernet header field boundary.

Table 2.1 Header format of ethernet

0000000000011010100011000110101110110101011001110100011011000110100010100011011110011111100010000100000000000010001010000000000000000001010000001010110111010111011001010101100	1110100011011000110100010100011011110011111110001	0000100000000000

From table 2.1, fill table 2.2 with respected value and explanation meaning of each field. Refer the following link for better understanding. Refer video 1 in material 1 for further understanding.

Reference Link : https://en.wikipedia.org/wiki/Ethernet_frame#Header
https://en.wikipedia.org/wiki/EtherType

Table 2.2 Header fields of Ethernet

Header Field Name	Length of Field (in bits)	Header field Value (Hex Value)	Meaning
Destination MAC Address	48 bits	00:1A:8C:6B:76:AC	Receiver's MAC address
Source MAC Address	48 bits	E8:D8:D1:46:F3F1	Sender's MAC address
Type	16 bits	0x800	0x800 indicates, Network Header type is IPv4 Header

2.3 Header format of Network

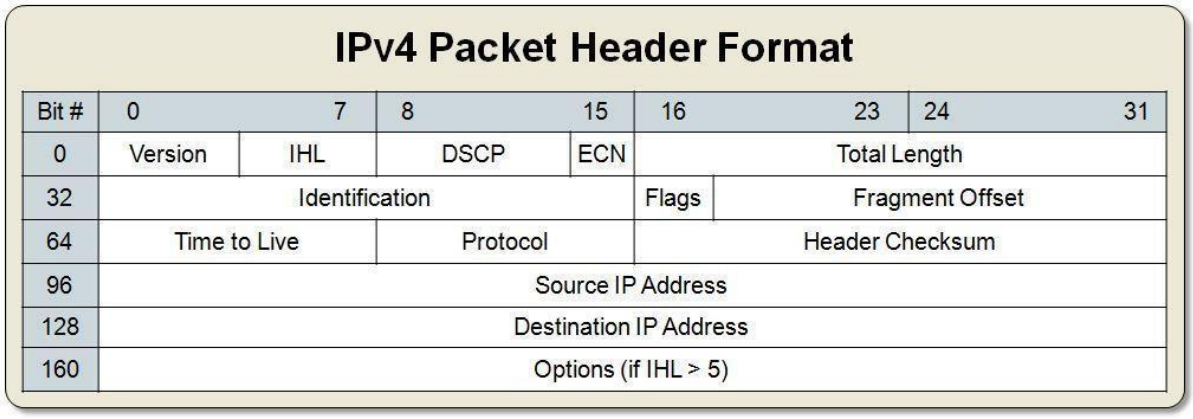

Figure 2.3 IPv4 header format

Section 2.1 contains bit stream. copy and paste respected number of bits into following table 2.3 to prepare ethernet header field boundary.

Table 2.3 Header format of network

0100	0101	000000	00	0000000000101000
0001010110111101			010	0000000000000
10000000		00000110		0000000000000000
10101100000100000000110001111011				
10001110111110101011011101001110				

From table 2.3, fill table 2.4 with respected value and explanation meaning of each field. Refer the following link for better understanding. Refer video 2 in material 2 for further understanding.

Reference Links:

https://en.wikipedia.org/wiki/IPv4#Header

DCSP & ECN: https://en.wikipedia.org/wiki/Type_of_service#DSCP_and_ECN

Flags: https://en.wikipedia.org/wiki/IPv4#Flags

Protocol: https://en.wikipedia.org/wiki/List_of_IP_protocol_numbers

Table 2.4 Header fields of Network

Header Field Name	Length of Field (in bits)	Header field Value (Hex Value)	Meaning
Version	4 bits	0x4	IP Datagram version 4
IHL	4 bites	0x5	5*32bits=160bits=20bytes
DSCP	6 bits	0x0	---
ECN	2 bits	0x0	---
Total length	16 bits	0x28	Total length of 40 bytes
Identification	16 bits	0x15BD	
flags	3 bits	0x2	2 bit More Fragment (MF)
Fragment offset	13 bits	0x0	This packet does not contain fragments.
Time to live	8 bits	0x80	128 Hops / Routers
Protocol	8 bits	0x06	This packet should be give to TCP receive procedure. As its value indicates TCP.
Header checksum	16 bits	0x0	No checksum included in this header.
Source IP Address	32 bits	172.16.12.123	Source IP: 172.16.12.123, its local machine
Destination IP Address	32 bits	142.250.183.78	Destination: 142.250.183.78, it is situated in_____country

2.4 Header format of transport layer: TCP

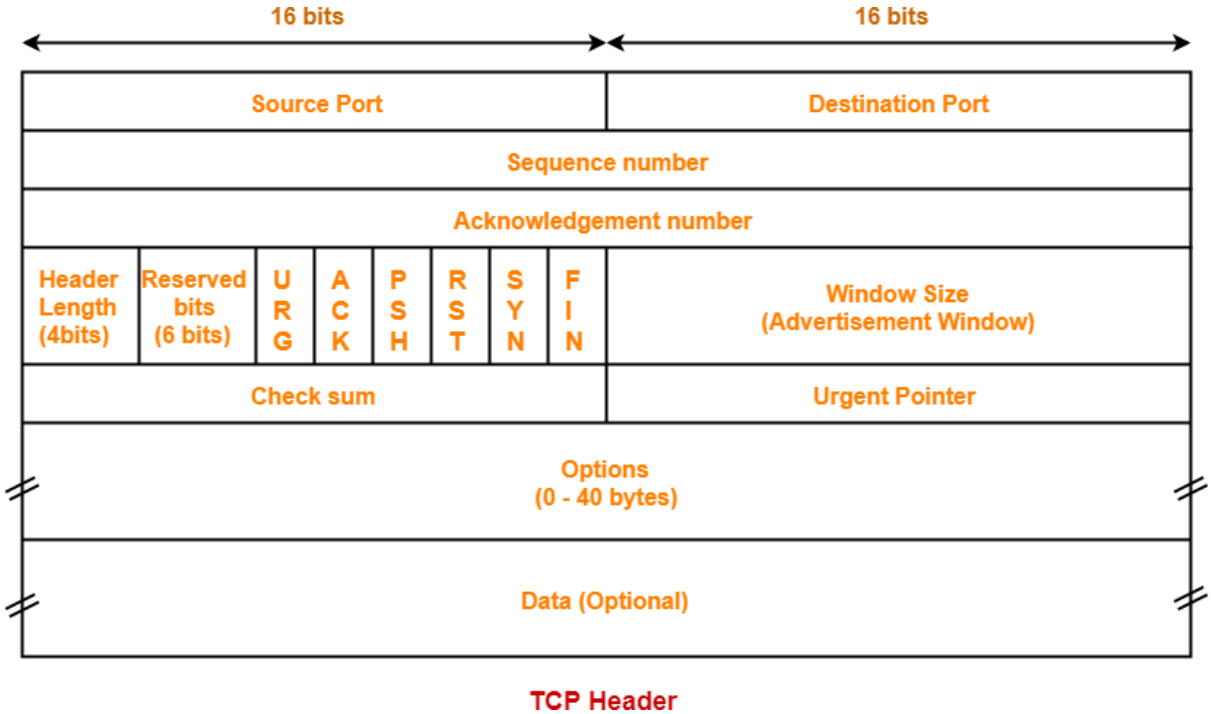

Figure 2.4 TCP Header format

Section 2.1 contains bit stream. copy and paste respected number of bits into following table 2.5 to prepare ethernet header field boundary.

Table 2.5 Header fields of transport layer

1100010101110011								0000000110111011
01001001111011110111110100011010								
11110010000010000001101000100111								
0101	000000	0	1	0	0	0	0	0001000000001010
1111111011101110								0000000000000000

From table 2.5, fill table 2.6 with respected value and explanation meaning of each field. Refer the following link for better understanding. Refer video 4 in material 4 for further understanding.

Reference Link :
https://en.wikipedia.org/wiki/Transmission_Control_Protocol#TCP_segment_structure
Flags: https://www.gatevidyalay.com/transmission-control-protocol-tcp-header/
Port : https://www.adminsub.net/tcp-udp-port-finder/

Table 2.6 Header fields of Transport Layer: _____

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
Source Port	16 Bits	50547	Sender machine's application's logical port number 50547.
Destination Port	16 Bits	443	Receiver machine's receiving logical port number 443 which indicates source wants communicate security using https protocol.
Sequence Number	32 Bits	0x49EF7D1A	Unique ID assigned by sender to maintain order of packers at receiver side.
Acknowledgement Number	32 Bits	0xF2081A27	This is acknowledge of sent packet.
Header Length	4 Bits	0x5	Total header Length is 5*32bits=160bits=20bytes
Reserved Bits	6 Bits	0x0	-
URG	1 Bit	0	
ACK	1 Bit	1	This packet contains valid acknowledgement number.
PSH	1 Bit	0	No Push
RST	1 Bit	0	No RST
SYN	1 Bit	0	No SYN
FIN	1 Bit	0	NO Fin
Window Size	16 Bits	0x100A	4106
Checksum	16 Bits	0xFEEE	Error identification in packet.
Urgent Pointer	16 Bits	0x0	No urgent content in this packet.

Exercise-1: Input Sequence TCP

11101000110110001101000101000110111100111111000100000000000110101000110001101011
01110110101011000000100000000000010001010000000000000000010100010111111110100 10
01000000000000000100000000000110110011101101000001100111001110111000110001100110
10101100000100000000110001111011000000011011101111110010110010000011000100010000
00000101111000001110010000000000010000101001101001010000000100000000000011111011
10110000100111010000000000000000000000000000000000000000000000000000000000000000

Header fields of Ethernet

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
Destination MAC Address	48 bits	E8:D8:D1:46:F3:F1	Receiver's MAC address
Source MAC Address	48 bits	00:1A:8C:6B:76:AC	Senders MAC address
Type	16 bits	800	0x800 indicates, Network Header type isIPv4 Header

Header fields of Network

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
VERSION	4bit	4	IP Datagram version 4
IHL	4bit	5	5*32bits=160bits=20bytes
DSCP	6bit	0	----------
ECN	2bit	0	----------
TOTAL LENGHT	16bit	28	Total length of 40 bytes
IDENTIFICATION	16bit	BFD2	
FLAGS	3bit	2	2 bit More Fragment (MF)
FRAGMENT OFFSET	13bit	0	-------
TIME TO LIVE	8bit	40	
PROTOCOL	8bit	6	This packet should be given to TCP receive procedure. As its value indicates TCP.
HEADER CHECK SUM	16bit	CED0	
SOURCE IP ADDRESS	32bit	673B8C66	259.89.320.258
DESTINATION ADDRESS	32bit	AC100C7B	172.16.12.123

Header fields of Transport Layer: _____

Header Field Name	Length of Field (in bits)	Header field Value (Hex Value)	Meaning
Source Port	16 Bits	01BB	Sender machine's application's logical port number 01BB.
Destination Port	16 Bits	F2C8	Receiver machine's receiving logical port number F2C8 which indicates source wants communicate security using https protocol.
Sequence Number	32 Bits	311005E0	Unique ID assigned by sender to maintain order of packers at receiver side.
Acknowledgement Number	32 Bits	E400429A	This is acknowledge of sent packet.
Header Length	4 Bits	0x5	Total header Length is 5*32bits=160bits=20bytes
Reserved Bits	6 Bits	0x0	-
URG	1 Bit	0	
ACK	1 Bit	1	This packet contains valid acknowledgement number.
PSH	1 Bit	0	No Push
RST	1 Bit	0	No RST
SYN	1 Bit	0	No SYN
FIN	1 Bit	0	NO Fin
Window Size	16 Bits	0xFB	4106
Checksum	16 Bits	B09D	Error identification in packet.
Urgent Pointer	16 Bits	0x0	No urgent content in this packet.

Exercise-2: Input Sequence of UDP

11101000110110001101000101000110111100111111000100000000010100000101011010101011
11110010011001110000100000000000010001010000000000000000001010000010000101011001
00000000000000001000000000010001101010011000100110101100000100000000101101000111
10101100000100000000110001111011111001110010000000001101001111010000000000010100
10001101001111111111010010000000000001011110011100000100000000000000000000000100
00000000000000010000111111011001000000000000000000000000000000000000000000000000

Header fields of Ethernet

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
Destination MAC Address	48 bits	E8:D8:D1:46:F3:F1	Receiver's MAC address
Source MAC Address	48bits	50:56:AB:F2:67	Sender's MAC address
Type	16bits	0x800	800 indicates IPV4

Header fields of Network

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
VERSION	4	4	IP Datagram version 4
IHL	4	5	5*32bits=160bits=20bytes
DSCP	6	0	----------
ECN	2	0	----------
TOTAL LENGHT	16	28	Total length of 40 bytes
IDENTIFICATION	16	2159	
FLAGS	3	0	2 bit More Fragment (MF)
FRAGMENT OFFSET	13	0	-------
TIME TO LIVE	8	80	
PROTOCOL	8	11	This packet should be give to TCP receive procedure. As its value indicates TCP.
HEADER CHECK SUM	16	A989	
SOURCE IP ADDRESS	32	AC100B47	172.16.11.71
DESTINATION ADDRESS	32	AC100C7B	172.16.12.123

Header fields of Transport Layer: _____

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
Destination MAC Address	48	E7200D3D0014	Receiver's MAC address
Source MAC Address	48	8D3FF48005E7	Sender's MAC address
Type	16	400	

Exercise-3: Input Sequence: ARP Broadcast

111111111111111111111111111111111111111111111111111000000110001111011010010101000
01110001010001000000010000000011000000000000000010000100000000000000000011000000100
0000000000000001111000000110001111011010010101000111000101000100101011000001000
0000100000010000100000000000000000000000000000000000000000000000001010110000010000
000001111001110100000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000

Header fields of Ethernet

Header Field Name	Length of Field (in bits)	Header field Value (Hex Value)	Meaning
Destination MAC Address	48 bits	FFFFFFFFFFFF	Receiver's MAC address
Source MAC Address	48 bits	E063DA5471 4 4	Sender's MAC address
Type	16bits	806	

Header fields of _________________

Header field Name	Length of Field (in bits)	Header field Value (Hex Value)	Meaning
VERSION	4	0	------
IHL	4	0	-------
DSCP	6	0	------
ECN	2	1	
TOTAL LENGHT	16	800	
IDENTIFICATIO N	16	604	
FLAGS	3	0	-------
FRAGMENT OFFSET	13	1	
TIME TO LIVE	8	E0	
PROTOCOL	8	63	
HEADER CHECK SUM	16	DA54	
SOURCE IP ADDRESS	32	7144AC10	113.68.172.16
DESTINATION ADDRESS	32	8210000	8.33.0.0

Exercise-4: Input Sequence: ARP Reply

11111111111111111111111111111111111111111111111101001100000100011011111110011101
11110011100010110000100000000110000000000000000100001000000000000000011000000100
00000000000000100100110000010001101111110011101111100111000101110101100000100000
00001110011010110000000000000000000000000000000000000000000000001010110000010000
00001110011010110000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000

Header fields of Ethernet

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
Destination MAC Address	48 bits	FFFFFFFFFFFF	Receiver's MAC address
Source MAC Address	48 bits	4C11BF9DF38B	Sender's MAC address
Type	16bits	806	

Header fields of _____

Header Field Name	**Length of Field (in bits)**	**Header field Value (Hex Value)**	**Meaning**
VERSION	4	0	------
IHL	4	0	------
DSCP	6	0	------
ECN	2	1	
TOTAL LENGHT	16	800	
IDENTIFICATION	16	604	
FLAGS	3	0	------
FRAGMENT OFFSET	13	2	
TIME TO LIVE	8	4C	
PROTOCOL	8	11	
HEADER CHECK SUM	16	BF9D	
SOURCE IP ADDRESS	32	F38BAC10	243.139.172.16
DESTINATION ADDRESS	32	E6B0000	14.107.0.0

Questions and answers:

1. What do you mean by TTL (Time to Live)?

Answer: TTL (Time to Live) in networking refers to a value in IP packets that dictates the maximum time or number of hops a packet can traverse in a network before being discarded.

2. What is the significance of Sequence Number and Acknowledgment Number in TCP format?

Answer: The sequence number in TCP format is essential for ordering and reconstructing data packets, while the acknowledgment number confirms the receipt of data and facilitates reliable data transmission between sender and receiver.

3. What is the full form of the MAC address? What is the significance of source and destination MAC address?

Answer: The full form of MAC address is Media Access Control address, and the source MAC address identifies the sender of a network packet while the destination MAC address specifies the intended recipient, crucial for data forwarding at the data link layer.

4. What is the full form of IP, TCP, UDP and ARP?

Answer: IP: Internet Protocol
TCP: Transmission Control Protocol
UDP: User Datagram Protocol
ARP: Address Resolution Protocol

Gate Questions:

1. **What is the maximum size of data that the application layer can pass on to the TCP layer below?**
   A) Any size
   B) 216 bytes - size of TCP header
   C) 216 bytes
   D) 1500 bytes

2. **The protocol data unit (PDU) for the application layer in the Internet stack is:**
   A) Segment
   B) Datagram
   C) Message
   D) Frame

3. **A TCP message consisting of 2100 bytes is passed to IP for delivery across two networks. The first network can carry a maximum payload of 1200 bytes per frame and the second network can carry a maximum payload of 400 bytes per frame, excluding network overhead. Assume that IP overhead per packet is 20 bytes. What is the total IP overhead in the second network for this transmission?**
   A) 40 bytes
   B) 80 bytes
   C) 120 bytes
   D) 160 bytes

4. **Which one of the following statements is FALSE?**
   A) TCP guarantees a minimum communication rate
   B) TCP ensures in-order delivery
   C) TCP reacts to congestion by reducing sender window size
   D) TCP employs retransmission to compensate for packet loss

5. **In TCP, a unique sequence number is assigned to each**
   A) byte
   B) word
   C) segment
   D) message

6. **Consider the following statements about the timeout value used in TCP.**
   i. **The timeout value is set to the RTT (Round Trip Time) measured during TCP connection establishment for the entire duration of the connection.**
   ii. **Appropriate RTT estimation algorithm is used to set the timeout value of a TCP connection.**
   iii. **Timeout value is set to twice the propagation delay from the sender to the receiver.**

   Which of the following choices hold?
   A) (i) is false, but (ii) and (iii) are true
   B) (i) and (iii) are false, but (ii) is true
   C) (i) and (ii) are false, but (iii) is true
   D) (i), (ii) and (iii) are false

7. **Consider an IP packet with a length of 4,500 bytes that includes a 20-byte IPv4 header ans 40-byte TCP header. The packet is forwarded to an IPv4 router that supports a Maximum Transmission Unit (MTU) of 600 bytes. Assume that the length of the IP header in all the outgoing fragments of this packet is 20 bytes. Assume that the fragmentation offset value stored in the first fragment is 0.**
   The fragmentation offset value stored in the third fragment is_____.
   Note –This was ..Numerical Type question.
   A) 0
   B) 72
   C) 144
   D) 216

8. **Consider two hosts P and Q connected through a router R. The maximum transfer unit (MTU) value of the link between P and R is 1500 bytes, and between R and Q is 820 bytes.**

   A TCP segment of size 1400 bytes was transferred from P to Q through R, with IP identification value as 0×1234. Assume that the IP header size is 20 bytes. Further, the packet is allowed to be fragmented, i.e., Don't Fragment (DF) flag in the IP header is not set by P.

   Which of the following statements is/are correct?
   A) Two fragments are created at R and the IP datagram size carrying the second fragment is 620 bytes.
   B) If the second fragment is lost, R will resend the fragment with the IP identification value 0×1234.
   C) If the second fragment is lost, P is required to resend the whole TCP segment.
   D) TCP destination port can be determined by analysing only the second fragment.

9. **One of the header fields in an IP datagram is the Time to Live(TTL)field.Which of the following statements best explains the need for this field?**
   A) It can be used to prioritize packets
   B) It can be used to reduce delays
   C) It can be used to optimize throughput
   D) It can be used to prevent packet looping

10. **In an IPv4 datagram, the M bit is 0, the value of HLEN is 10, the value of total length is 400 and the fragment offset value is 300. The position of the datagram, the sequence numbers of the first and the last bytes of the payload, respectively are:**
    A) Last fragment, 2400 and 2789
    B) First fragment, 2400 and 2759
    C) Last fragment, 2400 and 2759
    D) Middle fragment, 300 and 689

11. **The maximum number of IPv4 router addresses that can be listed in the record route (RR) option field of an IPv4 header is 9.**

12. **Consider an IP packet with a length of 4, 500 bytes that includes a 20 – byte IPv4 header ans 40 – byte TCP header. The packet is forwarded to an IPv4 router that supports a Maximum Transmission Unit (MTU) of 600 bytes. Assume that the length of the IP header in all the**

outgoing fragments of this packet is 20 bytes. Assume that the fragmentation offset value stored in the first fragment is 0.

The fragmentation offset value stored in the third fragment is 119.

13. **For which one of the following reasons does internet protocol(IP) use the time-to-live(TTL) field in IP datagram header?**
    A) Ensure packets reach destination within that time
    B) Discard packets that reach later than that time
    C) Prevent packets from looping indefinitely
    D) Limit the time for which a packet gets queued in intermediate routers

14. **One of the header fields in an IP datagram is the Time-to-Live (TTL) field. Which of the following statements best explains the need for this field?**
    A) It can be used to prioritize packets.
    B) It can be used to reduce delays.
    C) It can be used to optimize throughput.
    D) It can be used to prevent packet looping.

15. **Host A (on TCP/IP v4 network A) sends an IP datagram D to host B (also on TCP/IP v4 network B). Assume that no error occurred during the transmission of D. When D reaches B, which of the following IP header field(s) may be different from that of the original datagram D?**
    i. TTL
    ii. Checksum
    iii. Fragment Offset
    A) i only
    B) i and ii only
    C) ii and iii only
    D) i, ii and iii

16. **Host A sends a UDP datagram containing 8880 bytes of user data to host B over an Ethernet LAN. Ethernet frames may carry data up to 1500 bytes (i.e. MTU = 1500 bytes). Size of UDP header is 8 bytes and size of IP header is 20 bytes. There is no option field in IP header. How many total number of IP fragments will be transmitted and what will be the contents of offset field in the last fragment?**
    A) 6 and 925
    B) 6 and 7400
    C) 7 and 1110
    D) 7 and 8880

17. **An IP datagram of size 1000 bytes arrives at a router. The router has to forward this packet on a link whose MTU (maximum transmission unit) is 100 bytes . Assume that the size of the IP header is 20 bytes .**

    The number of fragments that the IP datagram will be divided into for transmission is 11.

18. **In the TCP/IP protocol suite, which one of the following is NOT part of the IP header?**
    A) Fragment Offset

B) Source IP address
C) Destination IP address
D) Destination port number